Numerical Investigation of Tip Geometry on the Tip-clearance Flow Features of a Pump-jet Propulsor

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ABSTRACT

The pump-jet propulsor is receiving increased attention for underwater vehicles due to the advantage of low acoustic signature. Cavitation inception and radiated noise seem to be closely related to the strength of the vortical flow that initiates in the clearance between the rotor tips and the duct. To the end of weakening the tip-clearance flow, different tip geometries are investigated via viscous flow CFD simulations.

The numerical simulation for pump-jet propulsors is based on the solution of the Reynolds-Averaged Navier-Stokes (RANS) equations using a two-layer realizable k-ε model for turbulence closure. The computational domain is discretized into block-structured hexahedral cells. To establish a reliable simulation model, the numerical uncertainties are evaluated according to the procedure recommended by the 28th International Towing Tank Conference (ITTC). Three sets of grids, with a uniform refinement ratio, are generated for a generic pump-jet propulsor at model scale using the grid generator ICEM CFD 17.2, and the flow simulations are carried out using the software package STAR-CCM+.

The tip-clearance flow features, such as streamlines and vortex strengths, are numerically investigated varied thickness and rake profiles of the sections close to the rotator tip. It is shown that the tip geometry has significant influence on the tip vortex.

Keywords: Pump-jet; Tip-clearance flow; CFD; Uncertainty

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